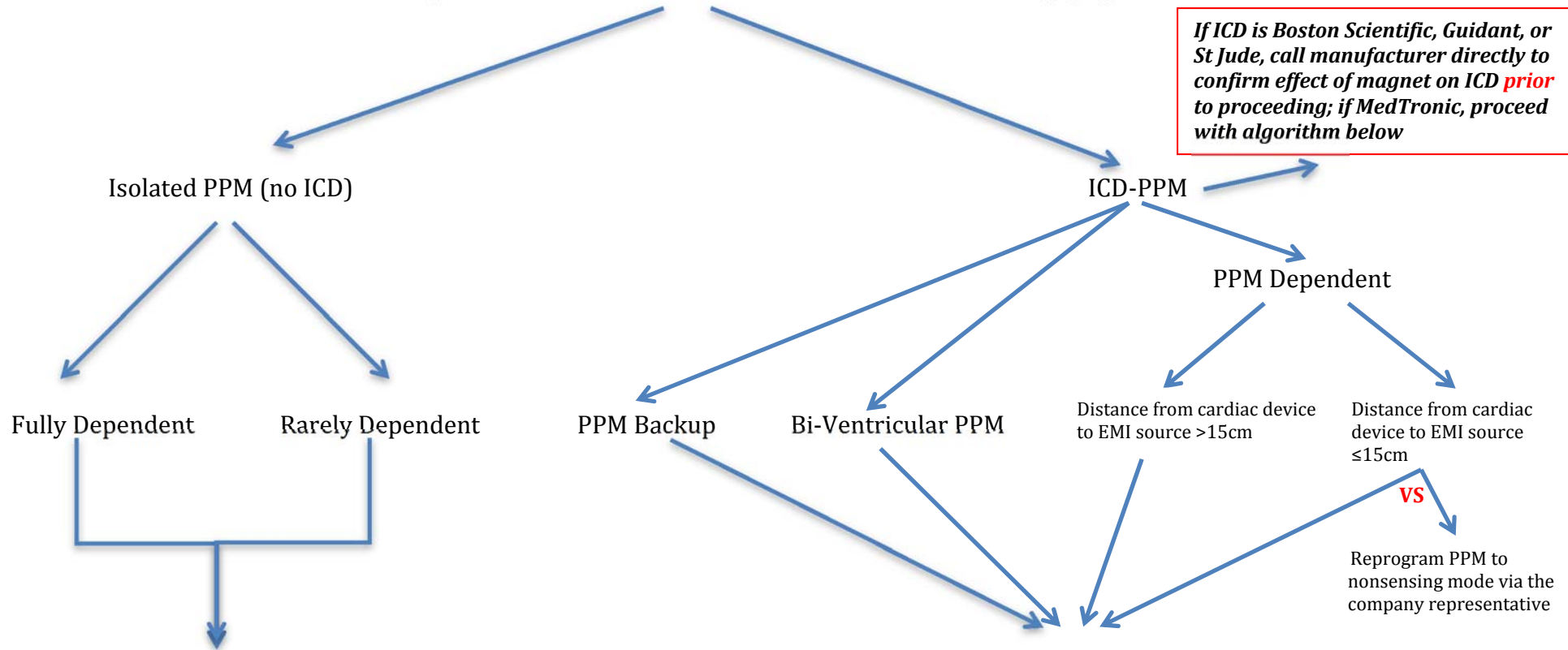


PPM: permanent pacemaker
 ICD: implantable cardioverter-defibrillator
 BiV: biventricular
 EMI: electromagnetic interference

Cardiac Devices (Determine Manufacturer and Device Type)



Proceed to surgery **WITHOUT** placing magnet on device and put bovie plate away from the device to decrease risk of interference; sterile magnet available in the operating room to revert to asynchronous mode if interference occurs

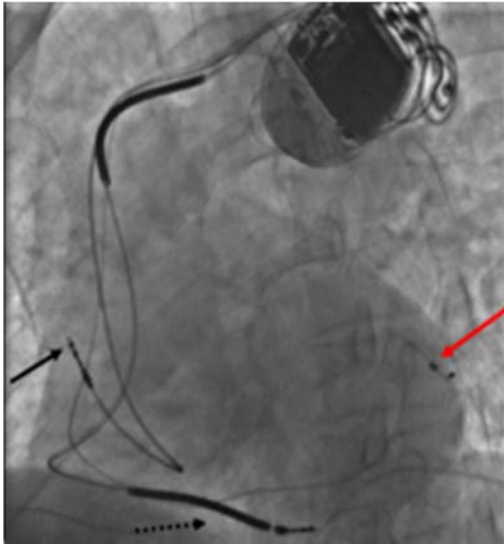
Place magnet over ICD thus deactivating ICD and leaving behind a functional and **unchanged** PPM device; put bovie plate away from the device to decrease risk of interference

The majority of the literature providing guidelines on the management of intra-cardiac devices prior to surgery is based on expert opinion. This algorithm is an attempt to combine that literature and our experience at Stanford Hospital & Clinics.

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Stanford Anesthesia Committee on Quality, Effectiveness, and Patient Satisfaction

Figure 1: Use of CXR to determine type of cardiac device. Generally the right ventricular (RV) lead of an ICD has two thick radio-opaque coils for defibrillation. Three leads can be seen in this cardiac resynchronization device: a right atrial lead (solid black arrow), a RV lead (dashed black arrow), and a coronary sinus lead (red arrow). The coronary sinus lead wraps around the outside of the LV, enabling pacing of the LV. Note the two thick radio-opaque coils for defibrillation of the RV lead, and the generator, which is larger than a typical pacemaker generator.



Magnet on ICD turns off ICD but does NOTHING to the PPM

EMI: Electrocautery, nerve stimulation, evoked potential monitors, fasciculations, shivering, large tidal volume, external defibrillation, MRI, radio frequency ablation, extracorporeal shock-wave lithotripsy, ECT

NO EFFECT: X-rays, Y-rays, UV rays, infrared

PPM: Described by a 5-letter code

1st Letter: chamber that is paced (AVD where A: atria; V: ventricle; D: both chambers; O: neither chamber)

2nd Letter: chamber where intrinsic activity is sensed (AVDO)

3rd Letter: the PPM response to a sensed impulse (ITDO where I: inhibit; T: trigger; D: inhibit or trigger; O: no response)

4th Letter: rate modulation (to increase cardiac output in the setting of activity, the PPM uses either body motion or, in the case of Boston Scientific thoracic cage impedance to increase HR); not really issue for us as patient immobile but important to consider effect of high respiratory rate while on ventilator when patients have Boston Scientific devices

5th Letter: multiple leads (the presence of a biventricular PPM)

i.e. VVI: V-paced, V-sensed, Inhibited-->when PPM senses a native impulse in the ventricle, pacing is inhibited

VOO: V-paced, no sensing and no inhibition-->PPM fires at a set rate regardless of native ventricle

DDD: atria and ventricle paced and sensed and both triggering and inhibiting are possible-->sequential AV pacing (most common programming such that if atrium fires on its own, the PPM senses it and inhibits atrial pace but will "listen" for native ventricular beat. If none happens, it will pace the ventricle but if native ventricle happens, PPM inhibits a ventricular pace

If sensing mode on, PPM can confuse the bovie signal as an intrinsic heart signal and therefore PPM does not fire HOWEVER new PPM have bipolar leads (i.e. the lead tips have both anode and cathode at tip so unlikely for EMI to affect PPM)

Magnet on solitary PPM will place PPM in non-sensing mode (DDD-->DOO, VVI-->VOO) at a rate dependent on the manufacturer and when magnet is removed, PPM reverts to original setting

PPM Approach: Indication for placement? Single (ventricle only) vs dual chamber (atria and ventricular leads)? Dependent for each impulse or only rarely when the HR is below a set limit (look at EKG or history)? Is A-V synchrony critical such as in patients with diastolic heart failure (HOCM)? What are the consequences of asynchrony in the specific patient--test the effect of asynchrony on blood pressure in the pre-op area if placement of magnet is done pre-operatively.

Rarely Dependent Patient: Proceed with surgery **WITHOUT** magnet and place bovie plate away from PPM; if hemodynamic instability due to dropped beats, either tell surgeon to stop bovie temporarily, use bipolar, or place magnet to convert to non-sensing mode

Pacer-Dependent Patient: Proceed with surgery **WITHOUT** magnet and place bovie plate away from PPM; **VERY UNLIKELY** to have interference but if hemodynamic instability due to dropped beats, either tell surgeon to stop bovie temporarily or switch to bipolar or place magnet to convert to non-sensing mode; if worried from beginning, consider placing magnet to convert to VOO (loss of synchrony) or DOO (non-sensing but AV synchrony); recall **however** that if convert to DOO, atria and ventricle are paced regardless of what the native atria and ventricle want to do so there can be competition and risk of "R on T" phenomenon-->to prevent this, need to place DOO at a rate that is higher than the intrinsic atrial rate requiring manual programming; similarly, VOO can also be pro-arrhythmic

ICD: delivers shock when VF or VT is sensed and bovie signal can be misinterpreted as VF or VT

All ICDs come with back-up PPM in case post-shock rhythm is asystole or bradycardia

Magnet on ICD turns off ICD but does NOTHING to the PPM in most ICDs

4 Main Companies: MedTronic, St Jude, BioTronik, Boston Scientific/Guidant

Medtronic: magnet placed on device deactivates ICD and when magnet comes off, ICD is back on; ALTHOUGH THERE IS NO NEED TO CHECK FOR SOUNDS ON THE ICD VIA THE STETHOSCOPE, MedTronic devices will make a single monotonous tone for 20-30 seconds when a magnet is nearby; alternatively, the ICD may rarely make a "European police siren" noise indicating an alert is present but does not specifically indicate the status of antitachyarrhythmia detection or therapies, however, if possible it should be interrogated prior to surgery

St Jude: mostly like MedTronic except for very old devices thus **we recommend calling company to confirm effect of magnet**

Boston Scientific/Guidant: read below for details--**in short, call the representative to discuss ICD management over the phone**

Magnet placement leads to R wave synchronous tones (use a stethoscope), wait 20-30 seconds, if tones persist, antitachy therapy is suspended until magnet is removed and when magnet removed, tones then stop confirming that anti tachy therapy is back; if initial placement of magnet leads to tones beeping followed by solid line (older devices), ICD permanently off and magnet can be taken off so to reactivate ICD, replace magnet and wait 30 seconds until hear tones again beeping confirming reactivation; if no tones ever heard from beginning, the device is programmed to ignore the magnet or the device is not Boston Scientific/Guidant

ICD- BiV PPM: in patients with very low output and widened QRS (i.e. native ventricles are asynchronous), a Bi-Ventricular PPM (leads in the RV and LV via coronary sinus) improves cardiac output by pacing both ventricles at the same time such that synchrony of the ventricles improves output; the manufacturer of the BiV device determines the native PR interval (i.e. intrinsic AV nodal delay) and then programs the BiV device's delay to be shorter than this such that you get BiV contraction prior to native asynchronous contraction; the BiV contraction inhibits native ventricular contraction so there is no competition; the EKG will show each QRS preceded by a spike **HOWEVER** they are not pacer-dependent per se as they have intrinsic rhythm however output improves when BiV paced

ICD Approach:

ICD and PPM-dependent: depends on the distance from cardiac device and EMI source but if distance >15cm, place magnet over ICD thus deactivating ICD and leaving behind a functional and **unchanged** PPM; given bipolar leads, unlikely to have bovie interference if bovie pad is placed away from device; if there is interference with hemodynamic instability and the surgeon cannot change to bipolar or surgeon cannot use short bursts, will need to have manufacturer come in to change to nonsensing modes (DOO or VOO); alternatively a more conservative approach is to pre-operatively reprogram to nonsensing mode with the aid of the company representative but then one must call them back to re-program manually

ICD and PPM-backup: place magnet over ICD to deactivate ICD, thus leaving PPM **untouched**

ICD and BiV PPM: place magnet over ICD thus deactivating ICD and leaving behind a functional and **unchanged** BiV PPM; reprogramming these patients to DOO maintains the BiV component however there is risk of "R on T" arrhythmia phenomenon; additionally, with MedTronic, changing to DOO automatically deactivates the ICD as well requiring manual reactivation by the company after surgery

RISK OF USING MAGNETS:

- In the RARE and UNLIKELY circumstance that a patient is ICD-PPM *dependent* or ICD-BiV PPM and develops intra-op interference AND consequently has hemodynamic instability refractory to changing to bipolar bovie or asking surgeon to use short bursts of bovie, then manufacturer has to come to operating room and manually re-program the device-->again, given the LOW PROBABILITY of this happening, safer to simply use the magnet

BENEFITS OF USING MAGNETS:

- Do NOT need manufacturer to make changes pre- or post-op
- Changing to non-sensing, asynchronous mode can change cardiac output significantly
- Decreased risk of patient leaving hospital with a deactivated ICD or altered PPM settings
- Regarding ICD, if patient needs shock in the operating room, simply remove magnet

Recommended indications for the interrogation of cardiac devices before patient discharge from the PACU:

Patients with devices reprogrammed before the procedure that left the device non-functional such as disabling tachycardia detection in an ICD

Patients with devices who underwent hemodynamically challenging surgeries such as cardiac surgery or significant vascular surgery (e.g. abdominal aortic aneurysmal repair)

Patients with devices who experienced significant intra-operative events including cardiac arrest requiring temporary pacing or cardiopulmonary resuscitation and those who required external electrical cardioversion

Cardiothoracic surgery

Recommendations for specific procedures:

RFA: magnet over ICD and PPM-dependent patients may be converted to asynchronous mode or monitored with backup magnet in the operating room

MRI: contraindicated unless it is the new Medtronic Revo PPM but call the company first to confirm

ECT: magnet over ICD

XRT: attempt to shield the device but no other changes

PHONE NUMBERS:

Medtronic: 800-782-7414

St. Jude: 800-722-3423

BioTronik: 800-547-0494

Boston Scientific/Guidant: 800-227-3422

CARDIAC DEVICE SUPER-USERS:

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